to a senior worker is severely tried. The book claims to be the first attempt to unite the well-established facts of astro- geo- and experimental-physics, and to refer the form of continents and sea basins, mountain chains, volcanoes and earthquakes, fossils, glacial periods, etc., to a single fundamental law of nature. The argument is briefly as follows: The cooling of the earth is discarded as a cause of surface crumpling, not because the process is insufficient, but because such cooling would—it is alleged—cause only tensile and not compressive forces in the crust (a complete misapprehension of the hypothesis). Insomuch as temporary stars have been explained as explosions of occluded gases, it is concluded that overwhelming catastrophes might thus be caused on the earth. The huge craters produced by such eruptions are most gratuitously assumed to be the means of determining the leading lines of terrestrial relief; the collapsing of the craters causes the lands to slide and wrinkle; and inasmuch as the successive catastrophes must have extinguished all forms of life, evolution is brushed aside and the Mosaic account of creation is re-established. The author's graphic skill is employed to illustrate the post-Tertiary changes of the continents in a series of six beautiful diagrams, whose absurdity would be amusing were their imaginative innocence not plaintive.

Much more might be said; but less would hardly constitute fair mention of a book that claims to be the 'outline of an exact cosmogony.'

W. M. D.

SOME RECENT RESEARCHES ON THE CHEMISTRY OF THE CELL.*

MIESCHER'S untimely death, after many years of patient work, left his epoch-making researches upon the chemical composition of the sperm of the salmon still unfinished. The results contained in the paper here reviewed represent but a small part of all that he accomplished, but this much only was it possible for Dr. O. Schmiedeberg to collect and put together from Miescher's scattered notes. Regarding the structure of the spermatozoon Miescher has little to add to his account of 1874. The head of the sperm consists of a hull and an inner substance. The hull was of alkaline reaction since it stained in decolorized cyanin, but not in methyl green. The inner substance stained deeply in methyl green. The head also contained a so-called 'Centralstäbchen,' apparently a prolongation of the tail forward into the head. No middle-piece could be distinguished.

1. *Histo-chemical Isolation.*—If the ripe, quite fresh sperm be centrifugalized, the sperm-fluid in which the spermatozoa float may be separated from them. This fluid was found to contain 0.19% organic constituents (a mere trace of albumen), and 0.75% inorganic salts, chiefly NaCl, Na_2CO_3, KCl and K_2SO_4. It is evidently a harmless fluid, analogous to physiological salt solution, in which the spermatozoa are suspended and which serves only to give the sperm-mass the necessary fluidity for ejection.

If, after removal of this fluid by Glauber's salts solution (in which the spermatozoa remain intact) the clean sperm be extracted with successive portions of water and many times centrifugalized, the tails swell and pass over into the fluid, leaving behind a sediment of sperm-heads. In this way it is possible to obtain separately heads and tails in sufficient quantities for separate analysis. Under the microscope the heads are seen to retain intact their characteristic form. Collected under alcohol they look like an inorganic, heavy, snow white powder like barium sulphate or calcium oxalate.

2. *Constitution of the Tails.*—Analysis of the substances obtained from the tails isolated in this manner show that they consist of 41.9% albumen not farther investigated; 31.83% lecithin, a body generally present in all cells but especially abundant in nerve-tissue; and 26.27% of fats and cholesterin. The fats consist of fatty acids, which occur as soaps. The tails contain no nucleic acid or protamin. In a letter to W. His the author writes: "The farther I go with the tails, the more probable it seems to me that we have before us essentially

*1. F. Miescher. Physiologico-chemical Researches on the Sperm of the Salmon (contributed by O. Schmiedeberg): Archiv für Experimentelle Pathologie and Pharmakologie, XXXVII., 1896.

2. A. Kossel. On the Basic Stuffs of the Cell-nucleus: Zeitschrift für Physiologische Chemie, XXII., 1896.

the chemical type of the non-medullated nerves, *i. e.*, of the axis cylinder."

3. *Composition of the Sperm-Heads.*—The analysis of the sperm-heads led to the surprising result that it is practically possible to express their constitution in a chemical formula, *i. e.*, that they are almost exclusively composed of one chemical substance. This substance is protamin nucleate,

$$10(\underset{\text{nucleic acid.}}{C_{40}H_{54}N_{14}O_{17},2P_2O_5},\ \underset{\text{protamin.}}{C_{16}H_{28}N_8O_2})$$
$$+ \underset{\text{free nucleic acid.}}{C_{40}H_{54}N_{14}O_{17}2P_2O_5}$$

For this research the heads were first extracted with ether-alcohol to remove the last traces of lecithin. The substances thus obtained were generally soaps, and amounted to only 0.74–2.56%. *The lecithin of the spermatozoon is thus shown to be confined entirely to the tail.* The poverty of the head in ether extractive is in striking contrast to the richness of the tails in such stuffs. The residue of the sperm-heads consists almost wholly of a mixture of the nucleic acid and basic protamin salts of nucleic acid.

The protamin, a simple albuminous body also isolated by Kossel from Sturgeon sperm, was isolated by treating the sperm with 0.25–0.50% HCl. The protamin passes into solution, the nucleic acid remains behind. There was thus obtained 19.78% of the sperm-heads as protamin. The hydrochloric acid extract also contained some calcium, iron, and calcium phosphates amounting to 2.94%.

The residue, after extraction of the protamin, consisted in large part of nucleic acid, a substance characteristic of all chromatins thus far examined. This constitutes, according to the phosphorus determination, about 60.50% of the sperm-head. The greater part of this nucleic acid is readily soluble in dilute sodium hydrate. There was thus actually isolated from the heads 95% of the total nucleic acid calculated to be present from the phosphorus content. It is certain from this determination that the total amount of phosphorus in sperm free from lecithin, except the trace occurring as phosphates, is contained in the nucleic acid.

After extracting the protamin and nucleic acid a small residue of the heads remained undissolved. This proved to be a compound of nucleic acid and protamin which had been slightly altered by the action of the extracting acid used, and so rendered less soluble.

From these analyses the composition of the salmon sperm is as follows: In sperm freed from lecithin and fat 87% of the substance lies in the head, and 13% in the tail. Of the original unextracted sperm (containing lecithin) 76% lies in the head and 24% in the tail. The tails consist of 41.9% albumen, 31.83% lecithin, and 26.27% fats and cholesterin. The heads consist of 35.56% protamin, and 60.50% nucleic acid, or 96.06% of neutral protamin nucleate. Of the other 4%, 2.5% were insolated as gypsum and calcium. The other 1% probably consists of albumen.

"The result that the fat-free heads contain 96% of protamin nucleate is astonishing. Since this salt is not an organized structure (Gebilde) it is questionable whether the heads, on the whole, contain any such. That the albuminous matter out of which such a structure must be compounded should be separated with the tails on the isolation of the heads is not to be considered, because the heads, after the isolation of the tails, on microscopical examination have the same appearance as before. Treatment with eosin, after good isolation, shows no trace of tail, middle piece, or other albuminous substance remaining behind, while the inner space may by the respective reagents be as beautifully differentiated as before. It (the inner space) has certainly a different nature from the hull, although both consist of the same substance. This difference rests apparently on the fact that nucleic acid and protamin are not uniformly distributed in the heads as a neutral salt, but in such manner that the *basic* protamin salt of nucleic acid occurs on the surface, and the *acid* protamin salt in the interior. This is indicated also by the fact, above mentioned, that after treating the heads with hydrochloric acid the nuclear colors are then also taken by the hull. That the hull has an alkaline reaction is proved by their blue coloration in decolorized cyanin solution, while the inner space remains uncolored."

"If the sperm, nevertheless, contains a special living structure (Gebilde) or a ferment-

stuff, the mass of the latter compared to that of the heads can only be extraordinarily small." Schmiedeberg then suggests that in such case the protamin nucleate might be the protector of this. This suggestion will hardly be accepted by those who believe in an active physiological *rôle* of the chromatin, since there can be no doubt that the protamin nucleate is the sperm-chromatin.

Miescher has also some interesting results on the differentiation of the chromatin (nuclei) during the formation and ripening of the sperm.

By treatment of the unripe testes with a solution of sodium taurocholate and calcium chloride, the nuclei of sperm-mother-cells and spermatocytes were isolated free from cytoplasm. *No protamin could be obtained* in the acid extract of these nuclei, although it may possibly have remained undissolved. There was obtained, however, an albuminose which proved to be practically identical in composition with a so-called deutero-myosinose isolated by Chittenden and Kühne from muscle. This is most interesting in the light of the fact that the salmon takes no food after entering the Rhine, and the material which serves as food for the developing testis is derived, as Miescher showed, from the body-muscles. Apparently, therefore, we have, in this fact, a chemical proof that the food-substance is taken into the nucleus. There can be little doubt that this albuminose is the mother-substance from which the protamin is differentiated during ripening. This fact is also in harmony with Kossel's observation that protamin can not be isolated from the unripe testis, and that protamin forms a combination with albuminoses not to be distinguished from the histon isolated from other nuclei.

Kossel's paper, published almost coincidently with that of Miescher, is of particular interest for two reasons: first, because Kossel finds protamin present in the sturgeon sperm as in the salmon; and second, on account of the important character which Kossel shows protamin to have. He finds that the sturgeon sperm yields protamin and nucleic acid, like the salmon, but contains a larger percentage of albumen. The protamin constituted, in the form of the sulphate, about 20% of the dried sperm (freed from fat and lecithin). The chemical analysis coincided with that obtained by Miescher in the protamin of salmon sperm, with the exception that sturgeon protamin contained one molecule more water. This may have been due, however, to incomplete drying. In physical character the two protamins differed. Thus, salmon protamin sulphate is easily soluble in hot water and on cooling separates out as an oil, while that of the sturgeon remains dissolved on cooling. The sturgeon protamin, too, is not so easily precipitated in strong salt solution as the salmon. Kossel also isolated substances resembling protamin and nucleic acid from the testes of the trout and the whiting, so that we are tolerably sure that a large portion of the sperm head of fishes consists of protamin nucleate.

Perhaps the most interesting part of the paper is that concerning the chemical nature of protamin. This substance is a basic body which gives all the reactions of albumen except that of Millon. Inasmuch as the latter reaction depends on the presence of certain radicles contained in albumen, these are seen to be lacking in protamin. Prof. Kossel suggests that protamin is the essential kernel of all albumens. We seem to have in protamin an albumen in the lowest terms. This is shown by the fact that on its decomposition protamin yields those products, arginin and lysin, which have so far been isolated from all albuminous bodies studied, but gives these products in very much larger proportion than albumen. Apparently albumen is protamin plus a greater or less number of other radicles.

The amido-acids were almost entirely lacking among the decomposition products. It is thus shown that protamin differs from the peptones in lacking the group out of which the amido-acids are formed. It follows also that the so-called biuret reaction of albumen is dependent on that group which falls into arginin and other bases.

Protamin unites in ammoniacal solution with albumoses, forming thereby bodies which could not be distinguished from the histon isolated by Kossel and Lilienfeld from the nuclei of the thymus gland. There are thus formed new albuminous bodies, which will yield more arginin than the original albumoses. "If we assume that this combination (Anfügung) also

takes place in the cell, we have an explanation of the fact, observed by Hedin, that different albuminous bodies yield on hydrolysis different amounts of arginin."

The fact that we have finally procured in protamin a chemically pure substance of a comparatively simple nature, which is, in all probability, the fundamental radicle of albumen, is of the very greatest importance in the study of the composition of the albumens, and may, perhaps, lead ultimately to their artificial formation.

In a third paper, 'On the Formation of Thymin from the Fish-sperm,' Kossel shows thymin to be a decomposition product of the nucleic acid of the sturgeon sperm, just as it is derived from the nucleic acid isolated from the thymus gland. He establishes its identity, also, with the body called 'nucleosin,' isolated by Schmiedeberg from the salmon sperm nucleic acid. From this there can be little doubt that these three acids are very closely similar in structure.

It has recently been found by the reviewer, in Kossel's laboratory, that the sperm of the sea urchin, *Arbacia*, also consists largely of protamin and nucleic acid.

It seems probable, from these results, that the head of the spermatozoon generally is composed of two very interesting substances, of nucleic acid, the essential chromatic constituent probably of all chromatins thus far isolated, free or combined, from yeast, pancreas and thymus gland; and of protamin, the radicle of albumen. The sperm seems to have rid itself of all superfluities and taken the essentials in their most compact form.

From Miescher's work we also have a good idea of the chemical nature of the sperm tail, although it is probable that the lecithin isolated therefrom is in reality combined in life with the albumen. As to the chemical nature of the middle piece little or nothing is so far known, but it is possible that, if the methods of histochemical isolation used by Miescher shall be found generally applicable, something may in time be learned of this.

We are still uncertain whether the protamin nucleate is identical in composition with the chromatin in the head of the living sperm, or whether in the process of isolation it has in some way changed, but the latter may not improbably be the case. At any rate it cannot be long until we have a general comparative chemistry of the chromatins, just as we have at present of the nucleins. The work of Kossel and Lilienfeld upon the chromatin of the calf's thymus, that of Kossel and Altmann upon the chromatin of yeast, of Hammarsten upon the pancreas chromatin, of Kossel upon the chromatin of the sturgeon's sperm and salmon, and that of Miescher upon the salmon sperm form the first stones of the foundation.

Albert Mathews.

SCIENTIFIC JOURNALS.

THE PHYSICAL REVIEW, VOL. IV., NO. 3, NOVEMBER–DECEMBER, 1896.

Experimental Determination of the Temperature in Geissler tubes: By R. W. Wood. It has been admitted for some time past that the light effects in Geissler tubes cannot be interpreted as indicating a high temperature. The phenomenon is unquestionably one of luminescence. Several writers, among whom Warburg may be especially mentioned, have discussed the theory of the phenomenon, and have arrived at results indicating that the temperature in an active Geissler tube is not greatly above the temperature of the surrounding air.

Mr. Wood has undertaken the difficult problem of actually measuring the temperature in the interior of a Geissler tube, making use of a fine wire bolometer so arranged that it could be moved from point to point through the tube. His results are, in the main, in agreement with the predictions of Prof. Warburg. The temperature in no case exceeds that of the surrounding air by more than 20 or 30 degrees. The temperature, however, is not found to be constant throughout the tube, but varies in accordance with definite laws throughout the space separating the two electrodes. The most striking results obtained by Mr. Wood apply to the case of a stratified discharge. In the curves which he presents to show the variation in temperature from point to point, a well defined ripple is seen corresponding to each layer or stratification. In passing from a bright layer